Innovative Ion Exchange Solutions for Small Community Nitrate Treatment Systems

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Topics we will cover

- Small system design challenges
  - Process considerations
  - Operational issues
- MinX product line
  - Systems in operation w/ performance summary
  - Nitrate Pilot results
- Case Study- CAPEX and OPEX costs
- Options for other contaminants

Small system design challenges

- Process considerations
  - Flow Rate, Peak/ Average vs. Reality
  - Influent WQ variability
  - System Utilization/ Availability
  - Treatment Goal, System vs. Overall
  - Waste Rate- 40% to 60% of OPEX

Small System Design Challenges

- Operational issues
  - Resources
    - Personnel
    - Financial
  - Infrastructure limits
    - Well pump and controls
    - Facility
    - Utilities
- Long term operation
  - Technical support
  - Process improvements
  - Changing regulations

Envirogen IX Systems-Smaller Flows

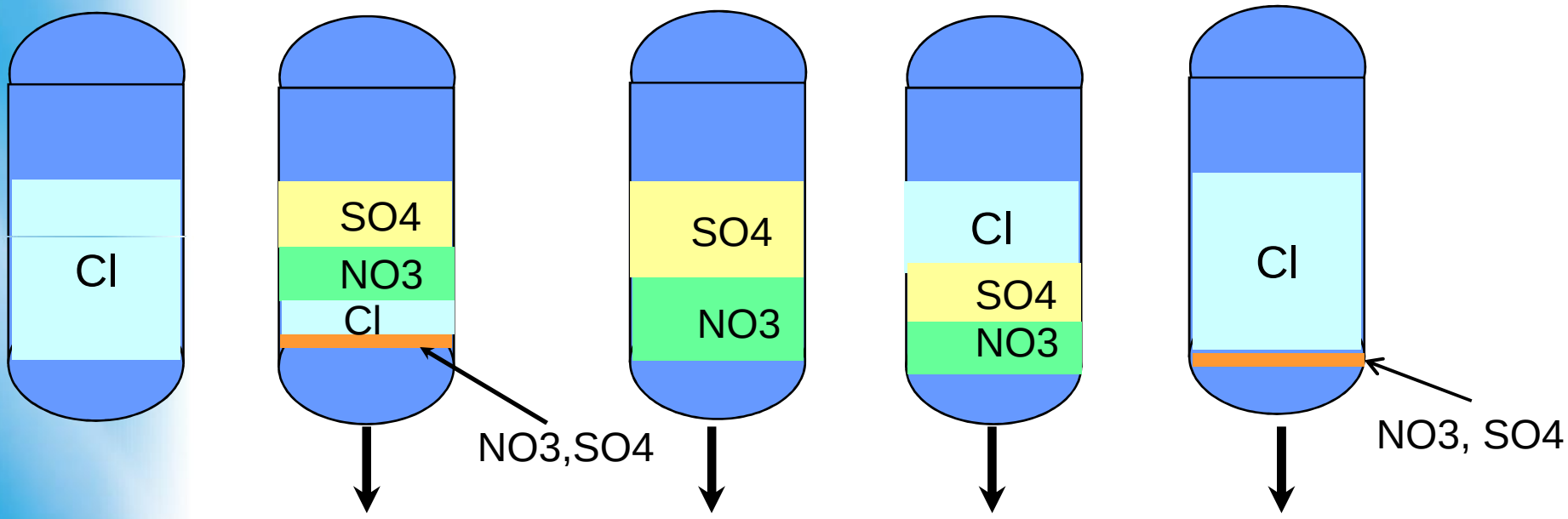
- MinX™
  - 20- 500 GPM
  - Regenerable IX system
  - Simplified SimPACK design for smaller applications
  - Indoor applications - i.e., well pump houses
- MinFlex™
  - 5-25 GPM capacity
  - Regenerable iX system
  - Low utilization, limited process control
- FlexSorb™
  - Classic service exchange business
  - Typically less than 100 GP
  - High BV applications
  - Intermittent use
- CleanPoint™

Regenerable Ion Exchange System Design

Recommended design basis- MinX

- Counter current regeneration- low NO_3 leakage
- Staggered (multiple) iX vessels, N+1 (N in service) - Internal Blending
- Two step brining process- Enhanced salt efficiency
- Water and brine recovery- minimize waste

Downflow – Co-current Regeneration



New

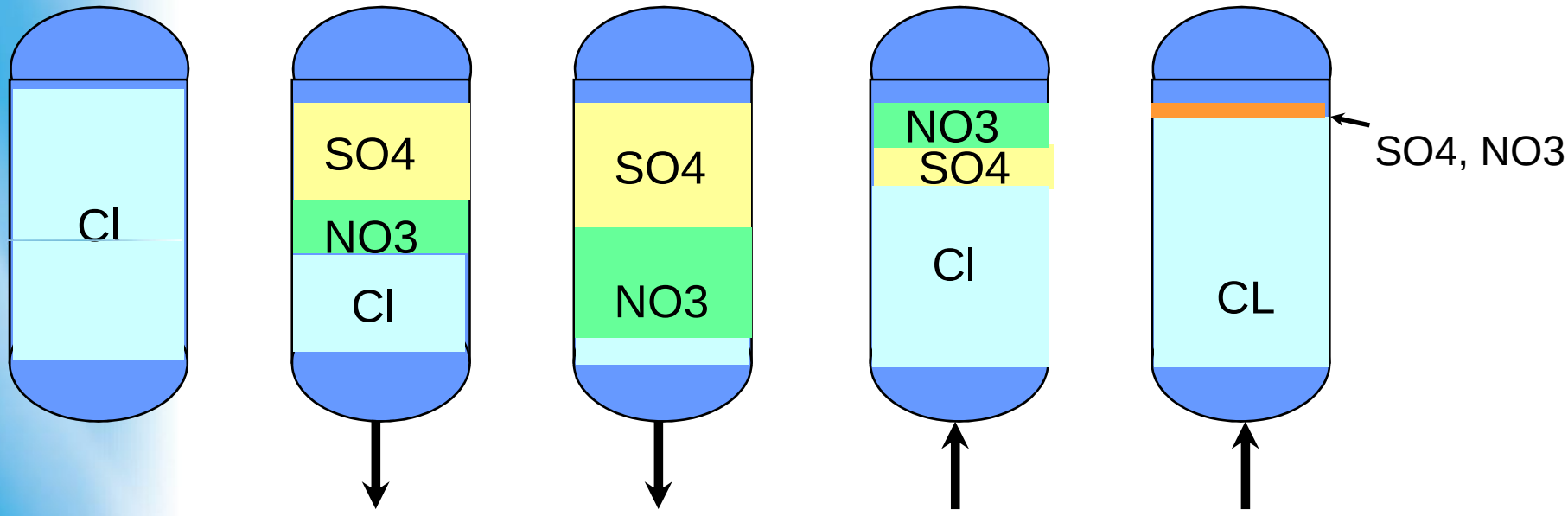
Partially Exhausted

Fully Exhausted

Partially Regenerated

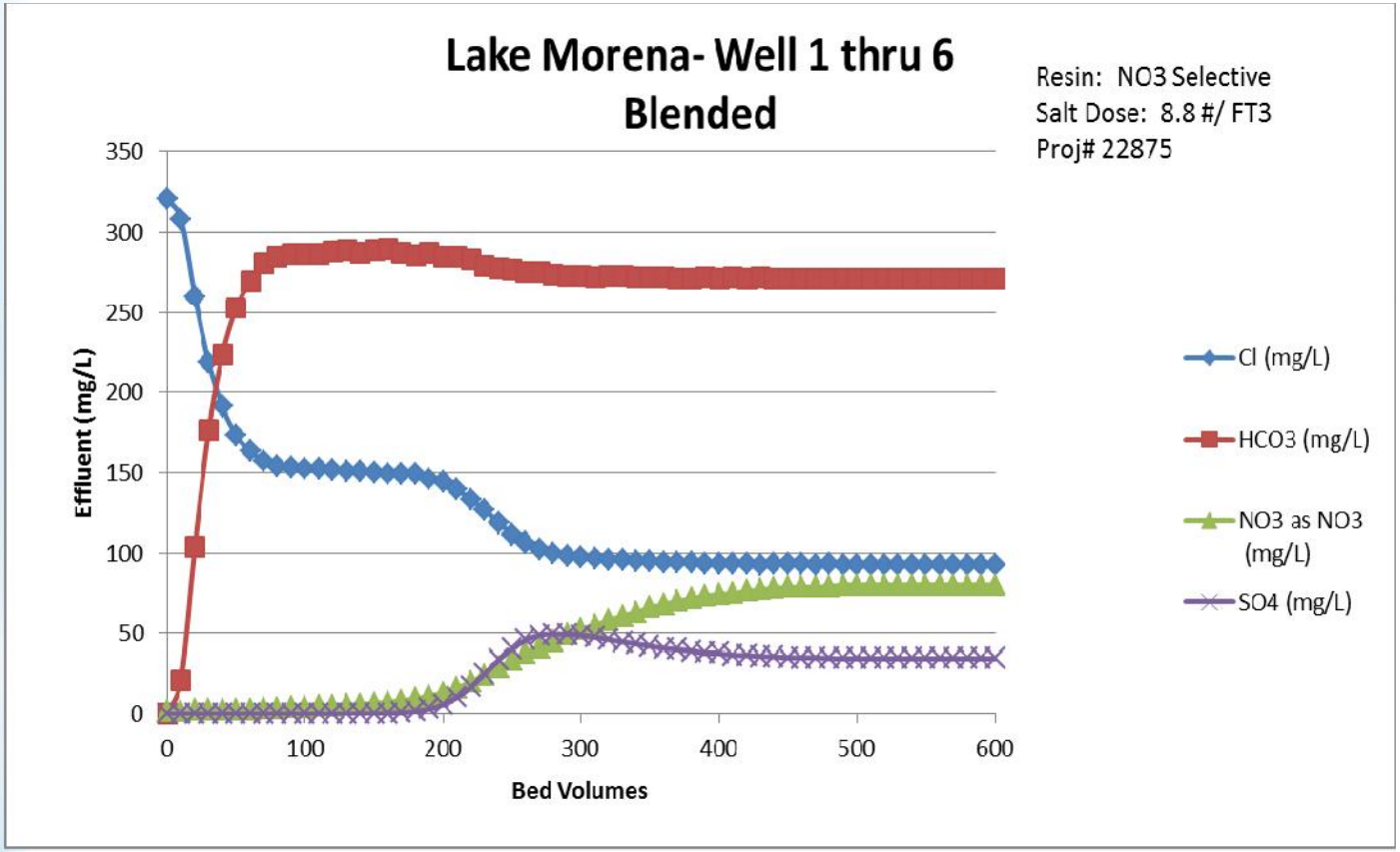
Fully Regenerated/ ADS

Packed Bed Counter-current Regeneration



Plug flow in both directions maintains wave front

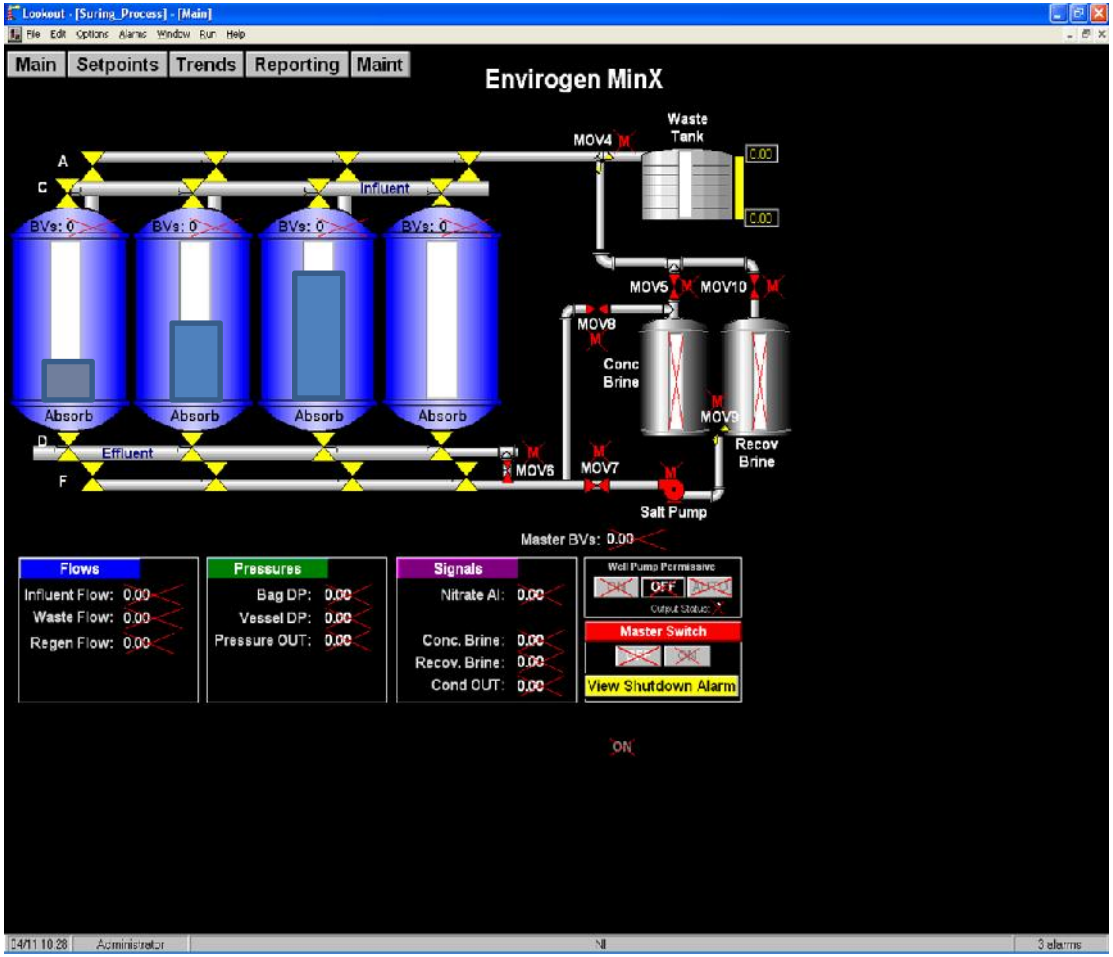
Single Bed Breakthrough



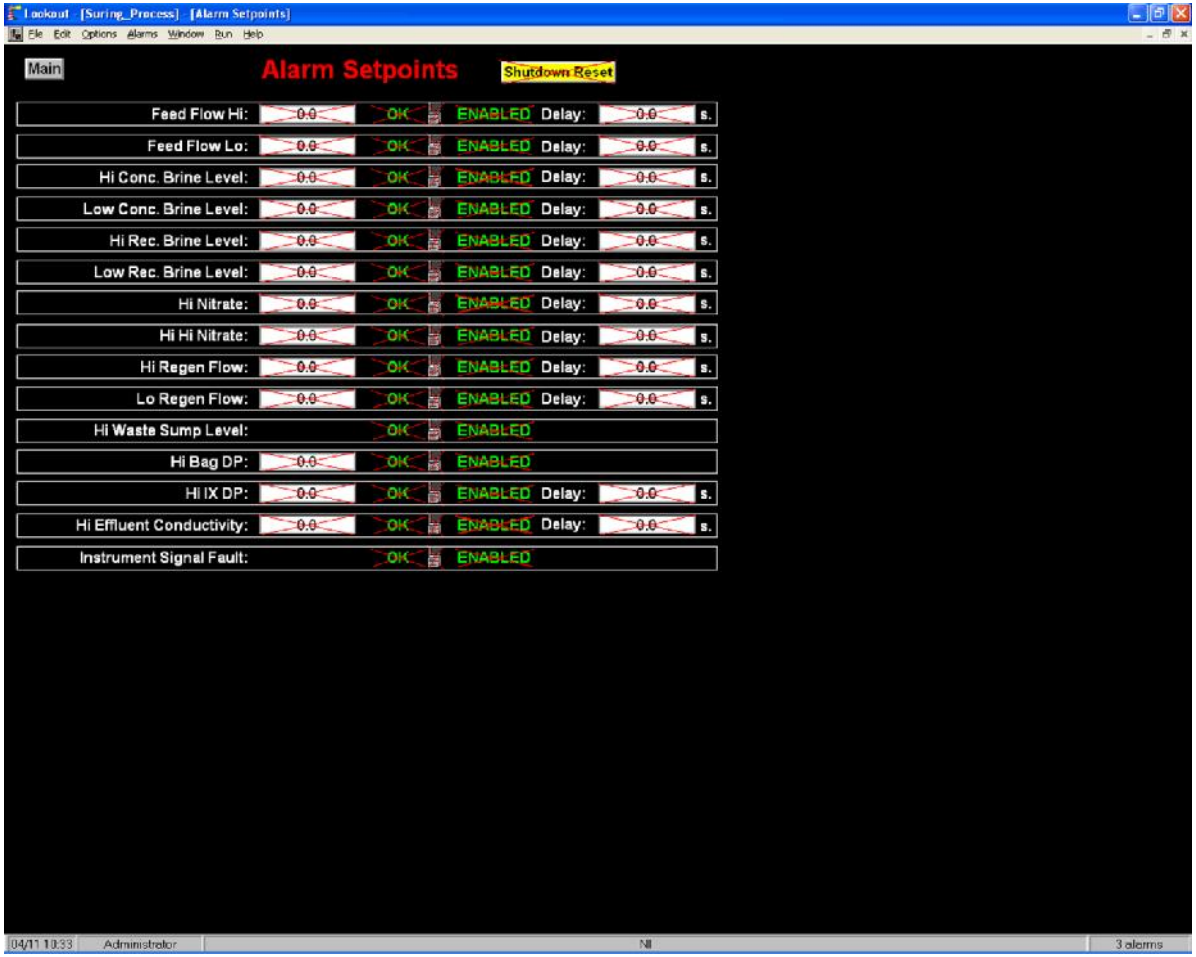
Staggered Bed Design- N=3

Influent NO3 (mg/L)	80.0			
NO3 Goal (mg/L)	36.0			
BV Set Point	445			
Vessels on line	3			
BV Waste	2.2			
BV Separation	148.3333333			
Vessel #	1	2	3	4
BV	445	296.6667	148.3333	0
NO3 Contrib	52.16804	49.13996	6.24712	1.61758
MAX Effluent NO3 (mg/L)	35.85			
Goal Met	Goal Met			
Waste Rate (%)	0.49%			
Goal Met	Yes			

MinX Process Controller



MinX Alarm Page



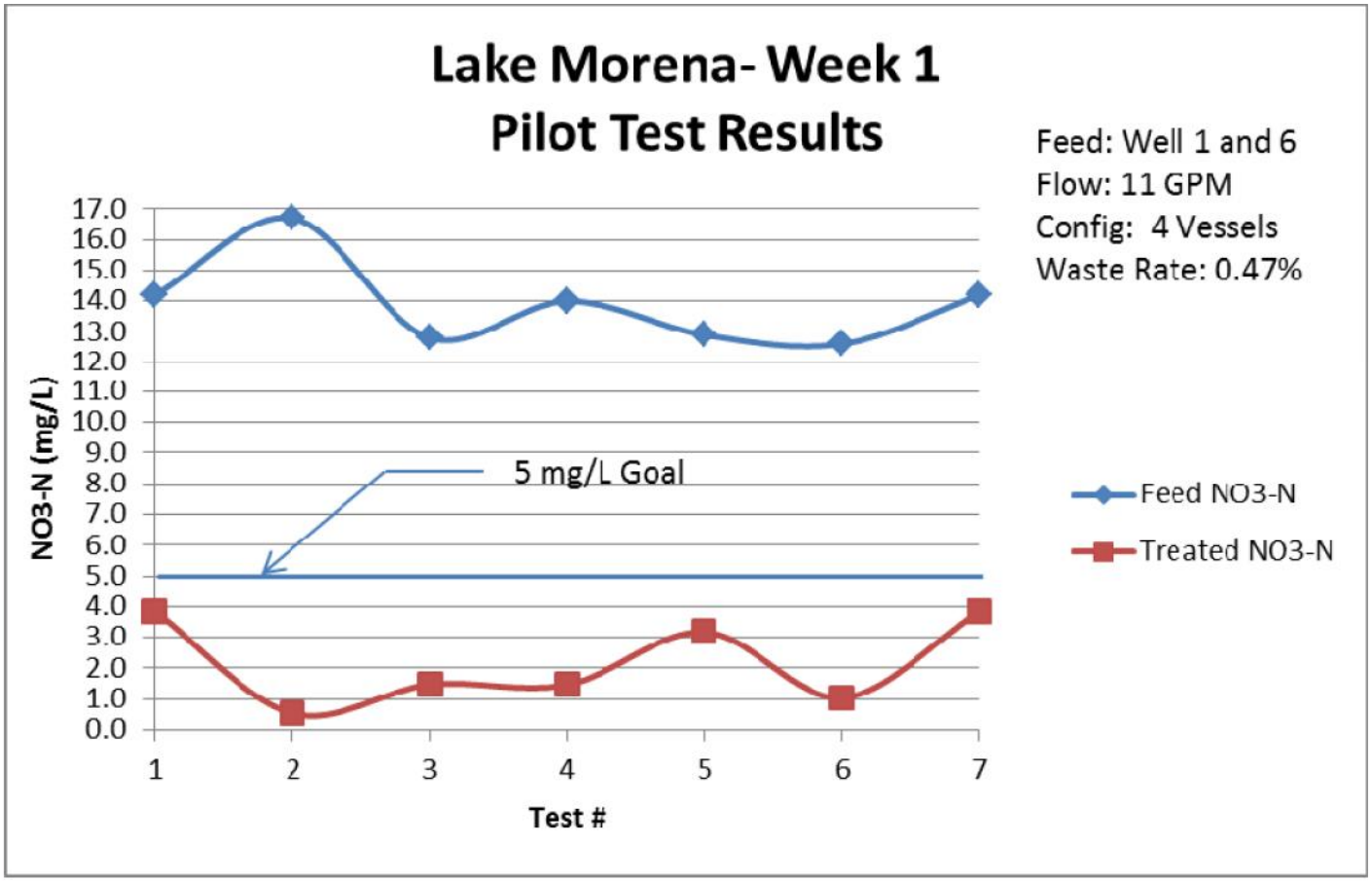
MinX System's Summary

- WI installation 1- 2010 Startup
  - Flow 350 GPM
  - NO3-N, Influent- 10.3 mg/L, Effluent- 3.0 mg/L
  - Waste Rate 0.51%
- WI installation 2- 2011 Startup
  - Flow 265 GPM
  - Arsenic, Influent- 12 µg/L, Effluent- <4 µg/L
  - Waste Rate 0.08%
- KS Installation- 2013 Startup (300 GPM- NO3)
- Lake Morena Oak Shores MWC- Pilot phase
  - Design Flow 50 GPM

Lake Morena's Oak Shores MWC

- 50 GPM Capacity
  - 200 connection
  - 5 wells, 5 -18 GPM capacity
  - Influent NO3-N, 12 - 23 mg/L
  - Well #5- Uranium at 40 pCi/L ± 40 pCi/L
  - Treatment Goal, <5 mg/L NO3-N
- Pilot Test
  - 4 week test
  - Goals
    - NO3-N <5 mg/L
    - Waste rate <0.5% for Nitrate feed ≤ 9 mg/L
    - Waste rate <1.2% for Nitrate feed between 9 and 25 mg/L

Pilot Test Results



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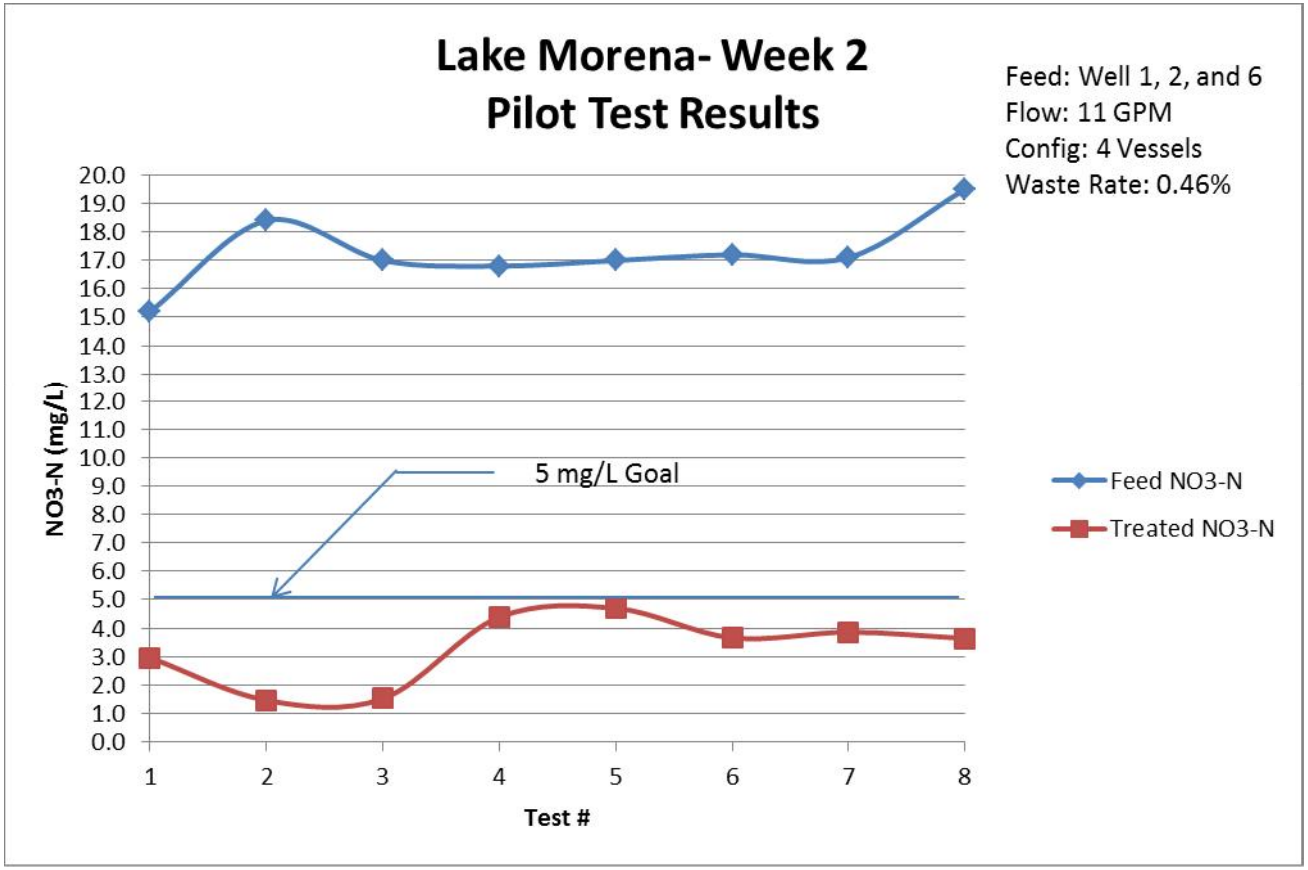

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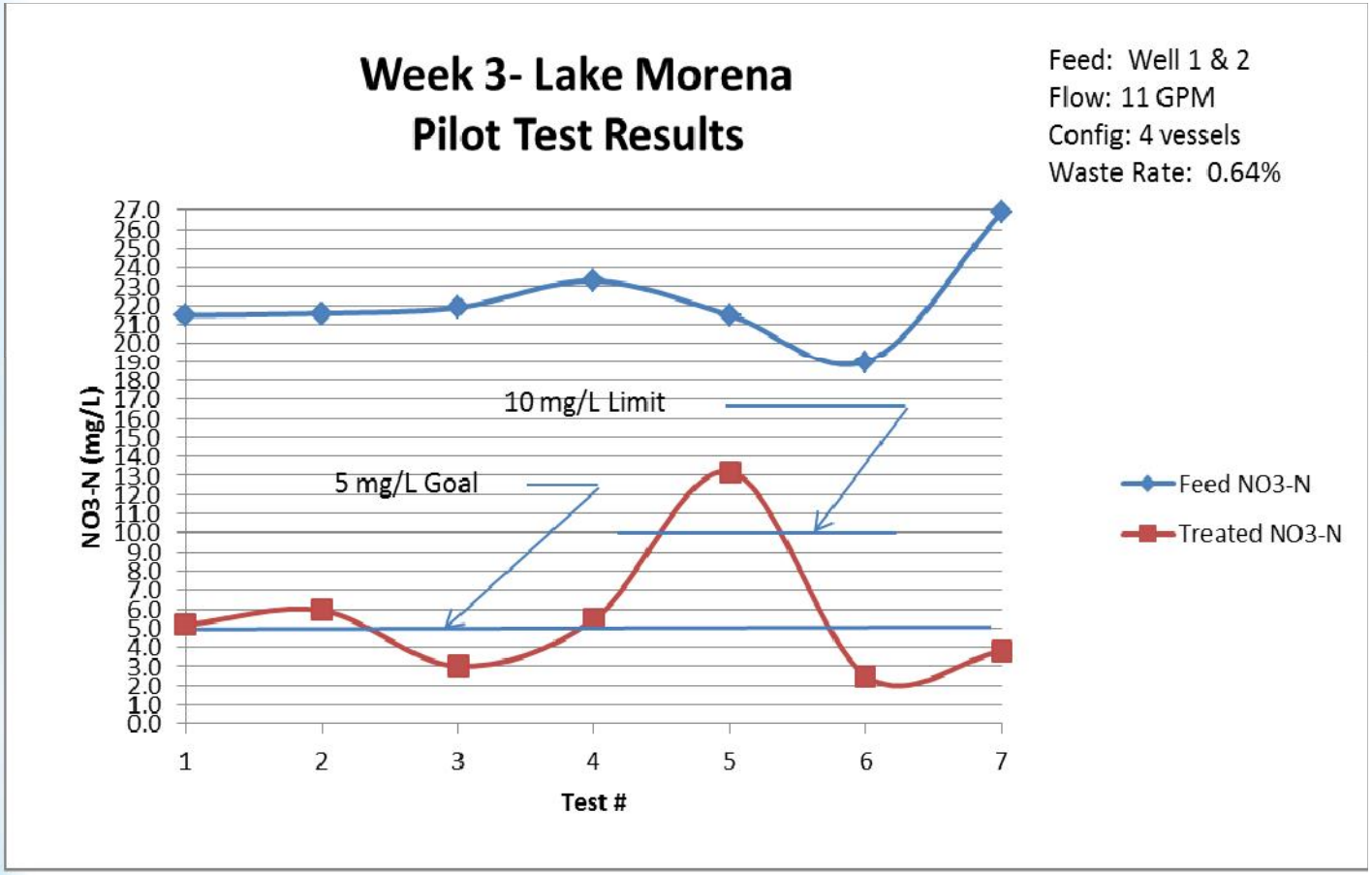

T-6 Pilot Trailer

T-6 Pilot Trailer

ENVIROGEN TECHNOLOGIES

Cost Summary- Case Study

- MinX capable of treating 125 GPM
  - No bypass required
  - 4 X Ø30” with 42” of media depth
  - N+1, 3 vessels on line, 1 vessel in regeneration/ standby
  - Staggered bed design, counter current regeneration
  - Brine and water recovery
  - NO3 analyzer, Post chlorination
- Process Conditions
  - BV Adsorption Set Point- 475 BV
  - Salt dose- 8 lb/ cf
  - Waste Rate- 0.48%, 12% NaCl concentration
  - Salt demand- 2.4 lb/ Kgal processed

Cost Summary- Case Study (Con't)

- Cost basis
  - Salt $125/ ton delivered
  - Waste Disposal $0.15/ gallon
  - Bag Filters $3/ bag
  - Labor $65/ hour, O/M

- Exclusions
  - Permitting costs
  - SCADA system

Cost Summary- Case Study

Description	Range
CAPEX	$375K - $438K
Equipment	$150K - $175K
Installation*	$150K - $175K
Engineering*	$75K - $88K
OPEX (Per MG treated)	$918 - $1,040

* Costs based on TDP capital factors

CleanPoint POE Treatment Systems

- Flow rate- 5 to 30 GPM
- Single use replaceable resin
  - Cr VI, As, ClO4, U
- Lead-lag configuration
- PLC control
- 500 gallon internal storage tank
- Pre-filtration, post chlorination unit
- Optional RF telemetry package

CleanPoint 10C (Flexsorb)

Conclusions

- MinX provides, reliable, cost effective contaminant (ionic species) treatment for smaller feed flows
- Operational factors are critical in the treatment decision process
- Regenerable resin (i.e. NO_3 and As) systems- Waste disposal is largest operation costs
- Replaceable resin systems- Good for small flow rates, intermittent use, and contaminants with long bed life.

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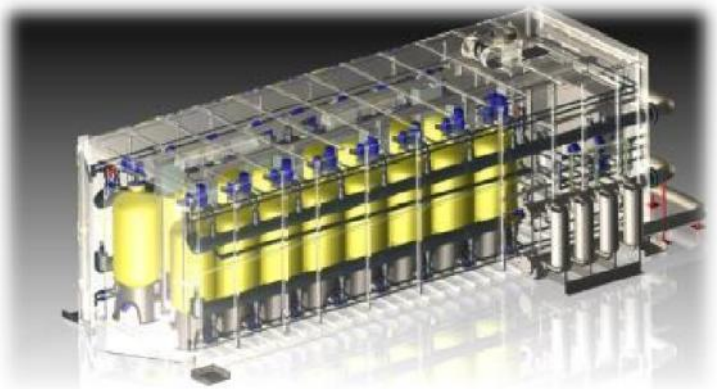
How we do it…

SimPACK™ Ion Exchange



Advantages of SimPACK multi-bed vs. conventional ion exchange

- Flows greater than 300 gpm
- Off-site regeneration is not feasible/desired and the customer wants/needs to minimize the waste volume (0.05%- 2% vs. 2% - 6% for competitors).
- Patented counter-current, cascading, two-vessel regeneration process.
- Small footprint, rapid deployment
- Reduction in salt consumption

Three-Step Process
Treat (exhaust)
Regenerate (on-site)
Rinse

SimPACK Design

- Resin is regenerated on sit
- Long-life resins
- The regeneration process is very rapid
- Multiple contaminants can be removed- “Long Term” View
- Robust and proven technology

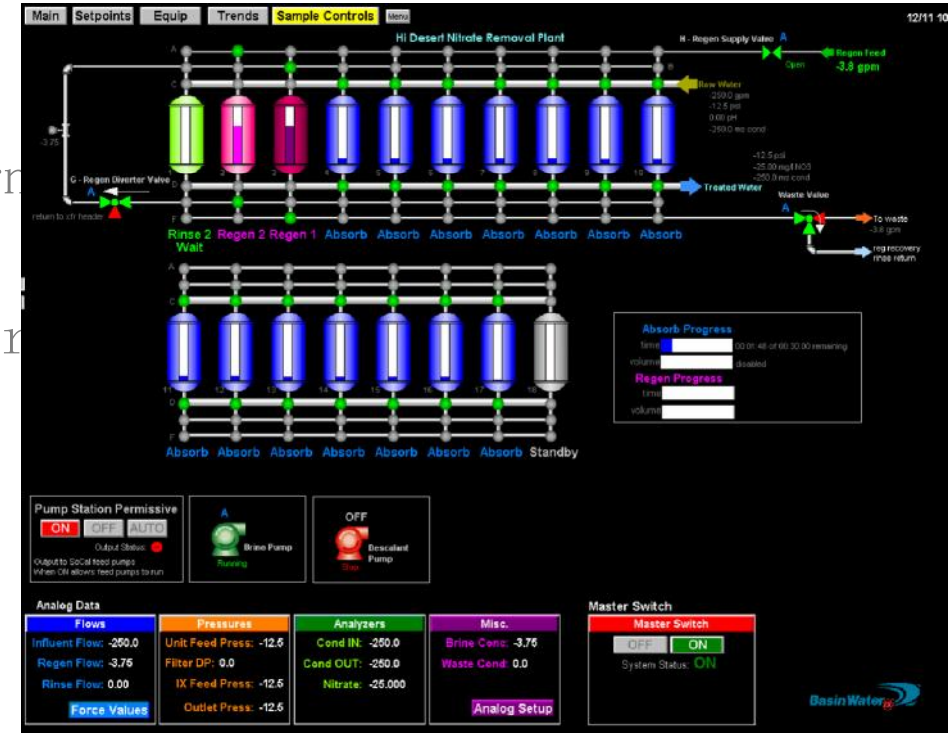
Containerized SimPACK™ System

Process Control

SimPACK™ Ion Exchange

Multi-bed design generates lower waste

- Staggered bed design
- Maximize bed volumes
- Consistent blending design
- Minimize brine waste
- Reuse of final rinse water
- Data logging capabilities
- Built-in redundancy
- PLC process controlled
- 24/7 Telemetry



What we treat...

Nitrate Removal Systems

1,000-GPM Nitrate Removal System - California

2,000-GPM Nitrate Removal System - California

What we treat…

Uranium Removal Systems

1,000-GPM Uranium Removal System - California

300-GPM Uranium Removal System - California

What we treat...

Perchlorate Removal Systems

2,000-GPM Perchlorate Removal System - California

1,000-GPM Perchlorate Removal System - California

Laboratory & Pilot Capabilities

- Current staff has 50+ years of industrial chemistry, laboratory and pilot experience
- Analytical equipment includes Graphite Furnace AA, Flame AA and Ion Chromatograph
- Wet chemistry capabilities include standard procedures and specific tests that relate to ion exchange evaluations
- Small-scale testing includes glass column media evaluations, precipitation and filtration tests

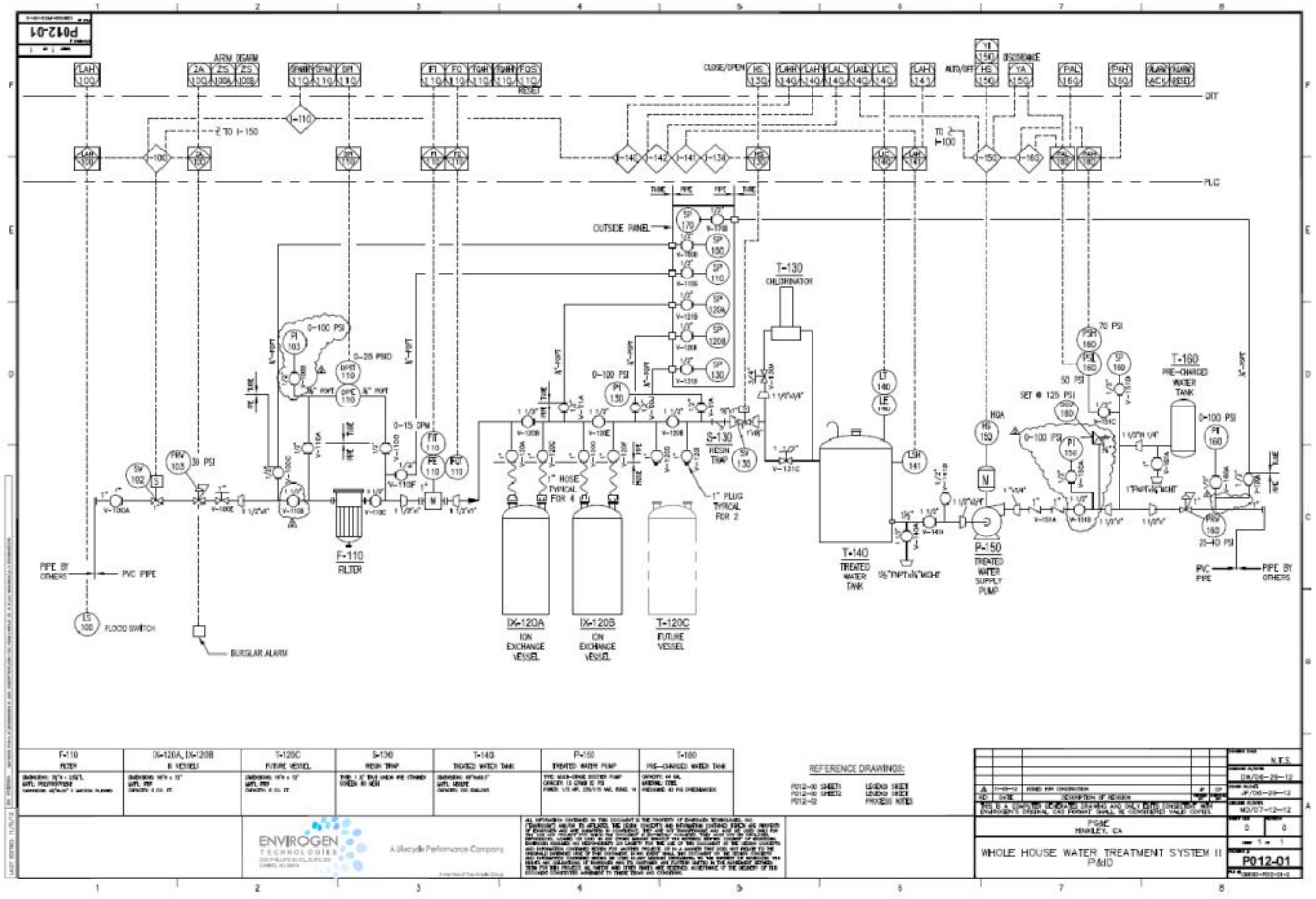
Kinetic Column

Cross Flow Filtration

Large-Scale Media Pilot

- Media and ion exchange evaluation using columns to several inches in diameter
- Kinetic column testing for media and ion exchange evaluations
- Testing of ion exchange resins and specially formulated selective resins and media
- Cross flow filtration pilots include ceramic, sintered metal and polymeric membranes
- Pilot RO system with 2.5-inch vessels
- Biological reactor pilots for on-site validation

CleanPoint 10C P&ID



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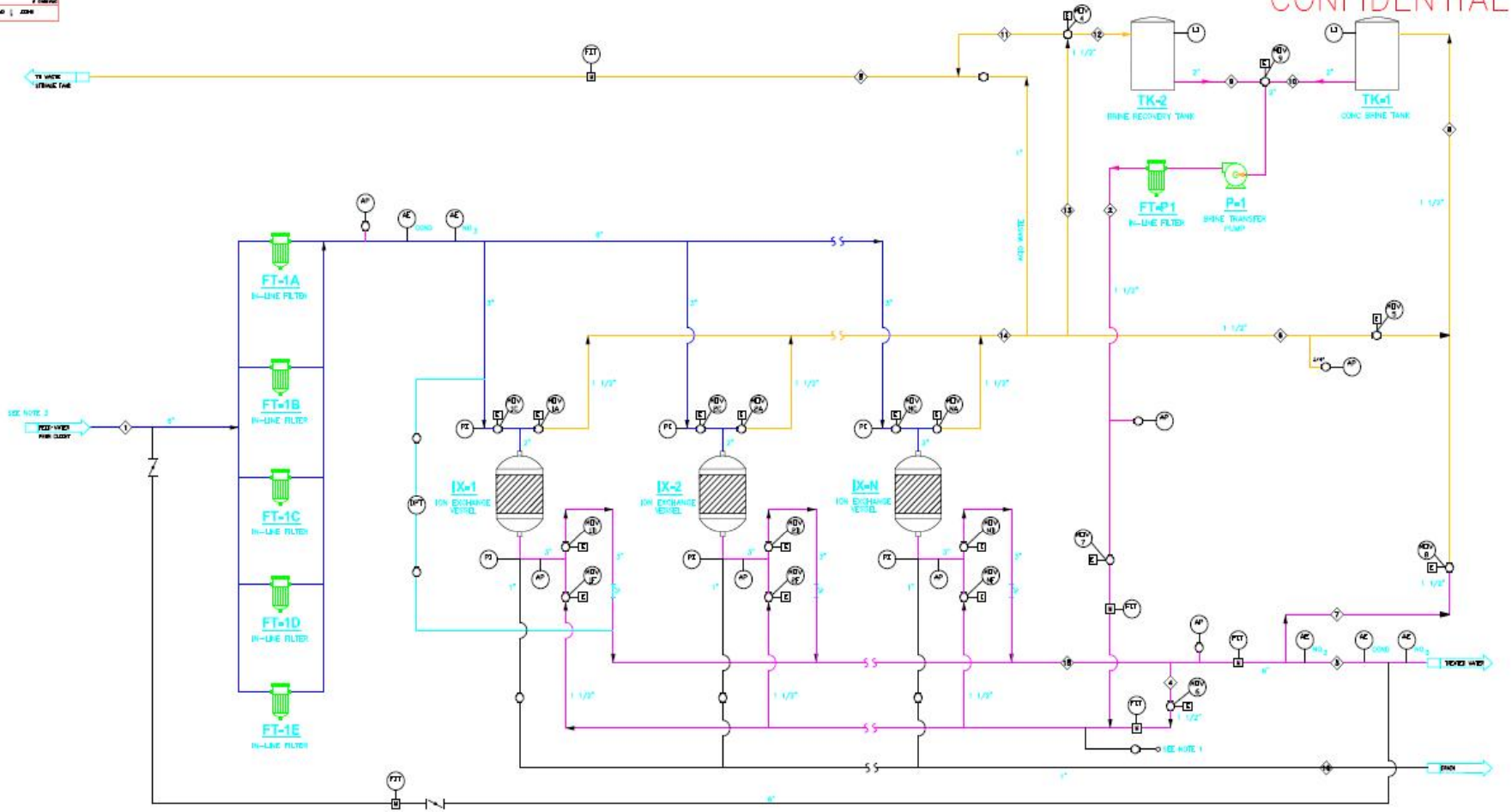

Material Balance

Characteristic		Water Feed	12 wt% Brine	Treated Water	Rinse	Waste Brine	Rinse Recovery	Brine Recovery
		1	2	3	4	5	6	12
Flow	gpm	450	--	--	--	--	--	--
Nitrate	µg/L	--	--	--	--	--	--	--
Iron	µg/L	--	--	--	--	--	--	--
Manganese	gpd	--	--	--	--	--	--	--

Note 1 : Intermittant Flow, Normal rate during operation is shown

GENERAL NOTES:

1. 8% HCl RINSE AS REQUIRED.
2. IX VESSELS, N=4
3. BYPASS TAKEN PRIOR TO FILTRATION.

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VILLAGE OF REEDSVILLE

NITRATE REMOVAL
PROCESS FLOW DIAGRAM

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